A Study of the Hydrological Geography of the Mogami Basins(1) Obanazawa Basin

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—— (1) Obanazawa Basin ——

Fujio ÔUCHI

Introduction

The natures of river water differ according to the geographical condition, that is, the physical and the cultural conditions of river. The former consists of the nature of soil (in the area of a water course), the topography, the type and amount of rainfall, the temperature in a river basin and the latter of the factories, hot-springs, towns, villages, agriculture,[1] mining industry, forestry, etc.—— these various conditions mingle and act another and present a complex feature. Even with a primeval river the feature differs according to the degree of erosion and plant-life, and so the author must say that in the investigation of a district he must take the nature of river water into consideration.

The author once published a treatise, entitled "On the Diurnal Variation of Hydrogen Ion Concentration (pH) in the River water[2]" and based on the same idea with which it was written, —— what the relation between river-water and human life is ——he surveyed the Obanazawa Basin which is now confronted by the problem how to better the soils of the rice fields there. This is a monocultural area[3] where a considerably low productivity (2 koku per tan*) prevails[4] and the rice fields occupy most of the terraces formed by the Nibu River.

It is a matter of profound interest, in distinguishing the characteristics of the area to study what mechanism causes the difference of the rice-crop and that of the soils[5] between one bank and the other of its midstream.

The geology of a greater part of this area cosists of volcanic rocks (acidic rocks) and limestone layer is found in a part.[6][7] The mountains around the basin are about 1000m high, and the rivers, its irrigation and measuring points are shown in Fig. 1.

This paper is a brief report of the results of his survey and in the near future he intends to discuss them in detail in the report of the Shinjô Basin.

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* Koku is the scale of the capacity in Japan. It is approximately equal to 4.9629 bushels. And tan is 0.1 chô. Chô is the scale of the acreage in Japan. It is approximately equal to 1,000 sq. m.

The Method of Survey

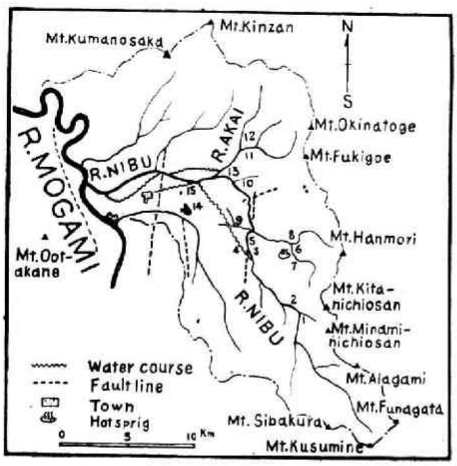

Fig. 1

As is shown in Fig. 1, this survey was made intermittently in the Nibu River and the Akai River in Yamagata Prefecture.

Surveying apparatuses are a Hydrogen Ion Concentration Calorimeter,** a Quick Hydrogen Ion Concentration Test Meter,*** and to survey the temperature of water a mercury thermometer was used. The author analysed the water of both the rivers, referring to Y. Miyake's, "Analysis of water" practical manual of chemistry[8][9] —— "Water, Air and Soil"[10] and Lanb. Carleton, meldrum.[11]

Survey on the Quality of Water in the Nibu River System.

The measurement derived from the investigation of the Nibu river system is shown in Table 1~2.

Table 1.

Surveying Point	
1.	Nabekowashi-zawa stream.
2	Nibu river damside.
3.	Tsurunokohara and Vicinity of the Nibu river.
4.	Tsurunokohara and Vicinity of Rokusawa main water couse.
5.	Shimoyanagi-Watado Nibu river.
6.	Ginzan river …… Ginzan hot-spring settelment.
7.	Ginzan river …… Ginzan water fall.
8.	Yakushi-zawa stream.
9.	Aō Trunk water cause.
10.	Name-zawa stream.
11.	Tozawa stream. (Akai upper stream.)
12.	Iwaya-zawa stream.
13.	Oshikuri Bridge …… Akai river.
14.	Tokura pond.
15.	Obanazawa Upper stream Trunk line…Nibu river.

** Hydrogen Ion Concentration Calorimeter made at Suzuki Co. Tôkyo, Japan.

*** Quick Hydrogen Ion Concentration Test Meter made at Shimaz Mfg. Co. in Kyôto.

Table 2.

Data of the chemical condition of the river water and irrigation water in the Obana-zawa Basin. Sept. 1st~2nd, 1951.

Surveying point and time.			Temperature °C		pH	R pH	H_2CO_3 mg/l	MCO_3' mg/l	SO_4'' mg'/l	Cl' mg'/l	NH_4
Point	Day	Hour	Air	Water							
1	2	11.50	21.7	17.8	4.33	4.37	5.5	8.8	42.0	none	none
2	〃	12.00	22.0	17.5	4.50	4.55	3.3	10.5	42.0	〃	—
3	〃	9.40	25.0	18.7	5.20	5.10	3.4	10.6	36.0	〃	—
4	〃	9.45	—	—	4.82	4.60	5.5	9.2	36.0	〃	—
5	〃	15.00	25.0	23.0	5.35	5.26	3.0	4.8	36.0	2.5	—
6	1	19.40	20.5	17.0	5.90	5.33	11.0	20.3	6.0	—	—
7	〃	18.20	18.0	18.0	6.73	6.20	9.3	25.1	20.0	—	—
8	〃	18.30	23.8	18.0	6.40	6.40	5.5	29.2	1.2	—	—
9	〃	17.20	29.0	21.0	7.40	6.80	16.5	23.6	65.0	—	—
10	〃	16.45	—	13.5	7.50	7.20	—	—	—	—	—
11	〃	18.55	23.0	20.0	5.60	5.60	8.0	11.4	37.8	15.0	—
12	〃	14.00	31.5	24.0	5.60	5.60	6.6	24.3	none	15.0	—
13	〃	13.10	30.5	23.5	7.60	7.20	8.3	39.6	6.0	30.0	—
14	2	16.30	25.5	Outlet 24.3 Surface 26.0	5.34	5.34	5.5	20.8	13.8	15.0	Trace

a) *Nabekowashi-zawa* The water in Nabekowashi-zawa scarcely contains any amount of sulphuric oxide ion and little carbonic acid compound, but much sulphuric acid ion. It is likely that there are sulphuric deposits or a sulphuric acid springs in the upper stream, and therefore the water is sulphuric.

b) *The Nibu river dam* The Nibu river has gorges near the dam. The temperatures of the water is somewhat lower than that of the Nabekowashi. Sulphuric acid is contained but chloric ion is not. A small quantity of isolated carbonic acid and compound carbonic acid is increased. The degree of acidity is low, (pH 4.5, RpH 4.55) and the water is sulphatical acid.

c) Tsurunokohara and vicinity of the Nibu river and Rokusawa main water-course. Comparing with the water near the Nibu dam, the water here shows about 1°C higher in temperature (18.7°C,pH 5.2,RpH 5.1), therefore, less acidulate. The water in the Rokusawa main water course shows more acid (pH 4.82, RpH 4.6) and contains soluted carbonic acid gas. A rainfall at the time of the survey may have affected a little. Sulphuric acid ion in both the river water and irrigation water is 3.6 mg/l.

d) *The water in the Nibu river in the vicinity of Shimoyanagi-Watado Bridge* The measurement at this place was carried on without a rainfall and the temperature was comparatively high. The water was pH 5.35 (temperature 18.8°C),

and strong acidity is shown.

From the above-mentioned survey the following facts may be conjectured; the water in the vicinity of Shimoyanagi-Watado bridge and Rokusawa trunk line which draws water from the upper stream is acidic and easily affected by a rainfall and other phenomena. When it rains the water becomes muddy at once and contains mineral acid. So it is not suitable for irrigation because it deposits acid soil in the rice fields.

The Survey on the Quality of the Ginzan River Water Line.

The auther surveyed the water near the junction of Yakushi-zawa, and the upstream of Ginzan hot-spring and the down stream of Ginzan fall (relative height is about 30m.) and investigated the effect of the hot-spring. This water course is led by a siphon to Aō trunk line and plays an important part to irrigate the hill-side fields of Tamano village. The temperature of the water in the basin is 17°C, comparatively low (pH 6.73, RpH 6.2), and dissolves much carbonic acid gas. The characteristic of the water here is that it dissolves little sulphuric acid ion and much carbonic acid chloride. The Ginzan river, by the confluence of the Ginzan hot-spring, changes its character and increases sulphuric acid —— NaCl and H_2S. The Ginzan hot-spring dissolves H_2S $2.288^{mg}/_{kg}$[12] and the water is less acid; combined with oxygen in the air, a part produces sulphuric acid and a part deposits separated sulphur. The Yakushi-zawa river contains little sulphuric acid ion and much carbonic compound.

a) *Aō trunk water course* This is led from the Ginzan river and over the Nibu river by a siphon. The measurement at Aō settlement shows a abundant sulphuric acid ion originated in Ginzan hotspring, but pH itself shows a slightly alkaline character. This alkaline character seems to be, at the first several years of the irrigation, suitable for somewhat acidic soils of volcanic ashes in this area. However, the water soon raises a great damage on rice fields through the aging effect by its sulphuric acid ion. There occur frequent damages of *Akiochi* (immaturity owing to the outbreak of Hydrogen Sulfide) and the yield decreases down rapidly and seriously. A great deal of lime has been used here every year in order to neutralize acidic ion, but it seems to have gotten little improved. The area irrigated by this water course is now in the worst condition in this vicinity.

Survey on the Akai River.

The Namezawa stream flows into the Nibu river from the east near the junction of the Nibu and the Akai, and a small mineral spring flows out, which

is alkalic. The river water here is also alkalic. This is due to the composing elements of the soil, that is, to the effect of limestone, the Oshikuri sandstone member contains. He thinks, the defect of the river water is its low temperature, but has a good quality as a irrigation water.

The temperature is low in the upper stream of the Akai toward the north of Iwayazawa hamlet in Miyazawa village, and it contains sulphuric acid ion, presenting mineral acidity. The author thinks this is caused by the presence of sulphur deposit or an acidic spring. So the water north of here is unsuitable for irrigation.

The Iwaya-zawa stream flows into the upper stream of the Akai at Iwayazawa hamlet, Miyazawa village from the northeast. On the upper stream there are an old ruined gold mine and other mines. The village authorities say the river is poisonous from a mine solution. But at an ordinary time the water is not bad for irrigation, though a heavy rainfall makes the earth contain poisonous ingredients the writer thinks.

The Akai river at the vicinity of Oshikiri Bridge —After joining the Iwayazawa stream, the Akai river crosses the area of the Oshikuri sandstone member of the Kanayama formation. The limestone of Oshikuri sandstone lies near the Oshikuri bridge, and the acidic water of the Akai presents a sudden change here, water being replaced by alkalic water. The irrigation channel is drawn near the Oshikiri bridge, irrigating about 150 chô of rice fields on the left bank of the Nibu river to the downe stream and flows into the latter. This area is the best rice fields in Miyazawa village. It is about thirty years since the rice fields were cultivated, and it is contrasted very much to the area irrigated by the trunk water course of Obanazawa upper stream in the vicinity of Nitobukuro settlement in Obanazawa town. Supposing there no change in the ingredients in the irrigation water (in fact, there must be a remarkable change) the amount of carbonic acid lime in the carbonic acid compound dissolved in the irrigation water is estimated as follows; this irrigation water course is about 1 meter deep, 1 meter wide, velocity is 20 meters per minute, so that the quantity of water carried per hour amounts to 1200 m^3 or 28800 m^3 a day. Supposing water is needed for 100 days in a year for rice the quantity of water needed is 2880000m^3. The quantity of carbonic oxide compound is estimated at 39600$^{mg}/_{m3}$ as it is 39.6$^{mg}/_{l}$. Therefore whole amount of dissolved carbonic oxide compound is about 114.048 ton converted into carbonic lime amounts to 190.08 ton. During the period of 30 years since the beginning of the cultivation of rice fields reaches 5702.4 ton or about 3.8ton of carbonic oxide lime per 1 tan, and this resulted in the improvement of soil and a good rice field that yields a good harvest. Concerning this, Mr.

T. Sasahara and Mr. T. Oyama of Obanazawa town say the rice crop per tan is 3 koku, while the crop in the rice fields irrigated by the Obanzawa trunk water way is about 1.5 koku per tan.

24 Hour Survey at the Mouth of Obanazawa Upper Stream Trunk Line Water Way, on the Midstream of the Nibu River.

The result of the survey at the mouth of Obanazawa upper stream trunk line on the midstream of the Nibu river is shown in the following table (Table 3). This is illustrated in the figure (Fig.2~3).

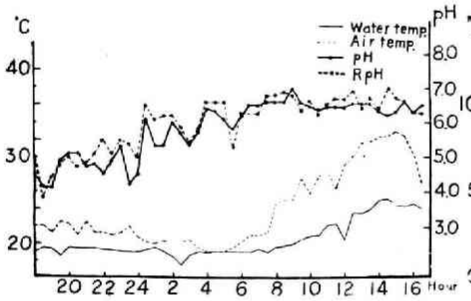

Fig. 1

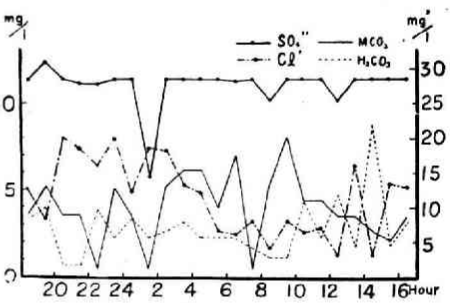

Fig. 2

These tables and figures explain that the muddy water shows the degree of acidity. Sulphuric acid ion is generally the same, RpH changing according to the change of pH. The change of pH is differnt from those of other river waters in the Tohoku District,[1] the nature of the river water showing a peculiarity. This indicates not only the complexity of the surface soil in the catchment area but also the ruinous conditions due to the land-slides and others found in the area where the rivers rise. It is presumed that fishing cannot prosper in this type of the river.

The Obanazawa upper stream tunk line water way irrigates about 200 chô of rice fields and reaches Toriage settlement, Obanazawa town. On the hills situated to the south of Obanazawa town there are low, gentle slopes of the Shimizu mebmer and the Yamuki member dotted with the groves of deciduous trees and fields. The Shimizu member deposit being an alternation of lignite and tuffaceous sandstone contains sulphur and sulphuric compounds, and sulphuric oxide ion is likely to be contained in the under-ground water and the stream on the surface. Accordingly, the rice fields irrigated by this water have a possibility of containing and dissolving or fixing iron, manganese and other effective elements suitable for the growth of plants. In fact, compared with the rice fields opposite

Table 3.

Data of the chemical condition of the river water of the Nibu river.
Data of the 24 hour survey at the mouth of Obanazawa upper stream trunk line water way on the midstream of the Nibu river. Aug 30-31st. 1951.

Hour	Tempeeature °C		pH	R pH	H_2CO_3 mg/l	MCO_3 mg'/l	SO_4" mg'/l	Cl' mg'/l	Remark column
	Air	Water							
1800	22.0	19.0	4 5	5.1	—	—	—	—	Muddy water
1830	22.0	19.5	4.1	3.8	3 3	3.6	27.0	12.4	〃
1900	21.2	19.3	4.1	4.4	—	—	—	—	〃
1930	22.5	18.5	4.9	4.8	4.0	5.3	30.2	8.0	〃
2000	22.2	19.5	5.1	5.0	—	—	—	—	〃
2030	21.0	19.4	5.1	4.7	0.6	3.5	27.0	20.0	Clear water
2100	22.5	19.4	4.7	4.8	—	—	—	—	〃
2130	21.2	19.4	4.8	5.1	0.6	3.5	25.8	18.4	〃
2200	21.2	19.2	4.5	5.5	—	—	—	—	〃
2230	21.0	19 2	4.9	5.1	3.9	0 4	25.8	16.0	〃
2300	21.2	19.1	5.3	5.5	—	—	—	—	〃
2330	22.0	19.0	4.2	5.4	2.2	5.1	27.0	20.0	〃
2400	20.6	19.0	4.5	5.0	—	—	—	—	〃
030	20.1	19.2	6.1	6.5	3.3	3.5	27.0	12.0	〃
100	20.0	19.5	5.3	6.1	—	—	—	—	〃
130	20.3	19.0	5.3	6.2	2.2	0.4	13.2	18.4	〃
200	20.3	18.5	6.0	6.2	—	—	—	—	〃
230	20.3	17.5	5.7	5.9	2.6	5.2	27.0	18 0	〃
300	20.4	18.6	5.3	5.4	—	—	—	—	〃
330	19.5	19.0	5.7	5.8	3.1	6.1	27.0	13.2	〃
400	19.0	18.9	6.4	6.6	—	—	—	—	〃
430	19.0	19.0	6.3	6.6	2.2	6.1	27.0	12.0	〃
500	19.0	19.0	6.1	6.6	—	—	—	—	〃
530	19.5	19.0	5.8	5.3	2.2	3.9	27.0	6.4	〃
600	20.2	19.0	6.2	6.3	—	—	—	—	〃
630	21.0	19.0	6.5	6.5	2.2	7.0	26.4	6.0	〃
700	21.0	19.3	6.5	6.3	—	—	—	—	〃
730	21.3	19.0	6.6	6.8	1.6	0.4	27.0	8.0	〃
800	24.5	19.6	6.6	6.8	—	—	—	—	〃
830	25.0	19.8	6.6	6.9	1.1	5.2	25.8	4.0	〃
900	25.0	20.0	7.0	6.8	—	—	—	—	〃
930	27.5	20.5	6.6	6.4	1.1	8.1	27.0	8.0	〃
1000	25.8	20.9	6.5	6.7	—	—	—	—	〃
1030	27.7	21.0	6.4	6.3	4.4	4.4	27.0	6.4	〃
1100	28.5	22.1	6.5	6.6	—	—	—	—	〃
1130	26.2	22.3	6.5	6.8	2.2	4.4	27.0	7.0	〃
1200	29.0	20.4	6.5	6.8	—	—	—	—	〃
1230	30.0	23.5	6.6	7.0	4·7	3.5	25.8	2.9	〃
1300	31.6	23.5	6.6	6.5	—	—	—	—	〃
1330	31.8	24.0	6.6	6.8	1.7	3.5	27.0	16.0	〃
1400	32.4	25.0	6.4	6.5	—	—	—	—	〃
1430	32.5	25.2	6.3	7.1	8.8	2.6	27.0	3.2	〃
1500	33.0	24.3	6.4	6.8	—	—	—	—	〃
1530	32.5	24.3	6.7	6.7	1·8	2.1	27.0	13.6	〃
1600	30.5	24.5	6.4	6.4	—	—	—	—	〃
1630	27.0	24.0	6.6	6.4	3.2	3.5	27.0	12.8	〃

the above mentioned bank irrigated by the water of the Oshikuri, productivity is less and its crops are poor, accordingly.

Tokura Pond and Irrigation Water in the Vicinity.

Tokura pond is about 3 km nearly east of Obanazawa town. This pond is surrounded by gently sloping hills which are low on the northern side. This is supplied with water from Rokusawa and Aô trunk water-ways and rain-water. The water here shows organic acidity and contains a small amount of amonium. The rice fields on the upper hills of Obanazawa town are irrigated by the water from this pond which flows into the Oboroke, the Nibu and the Mogami rivers. The organic acidity of the water in the pond, the author presumes, is attributed to the following fact; mineral acidic water (chiefly sulphuric acid) acts on organic compounds in the earth and replacing phenomenon takes place between sulphuric oxide which is a heavy acid and organic which is frail acid and causes acidity.

Summary

The results of the above-mentioned survey are as follows;

(1) The water in the Nibu and Ginzan rivers and their line contains sulphuric oxid and presents chemical acidity.

(2) The upper stream of the Akai river contains sulphuric oxid ion and chlorine ion and is chemically acid, while in the down stream below the Oshikuri bridge the water is alkaline and is suitable for irrigation.

(3) Tokura pond is organic acid which may be attributed to the replacement of inorganic acid and organic acid. This phenomenon accelerates the aging effect of rice fields, the author supposes.

(4) Concerning the soils of the rice fields on both banks of the Nibu river, it has been recognized that the soils on one side is acidic, and that on the other is neutral. But this is caused by the different nature of the irrigation water and the soils are of the same quality in themselves.

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